1. Title: **December 2001**

Demographic characteristics of northern spotted owls (*Strix occidentalis*) on the Tyee Study Area, Roseburg, Oregon: 1985-2001.

2. Principal Investigator(s) and Organization(s):

Dr. E.D. Forsman (PI), Lead Biologist: J. Reid, Pacific Northwest Research Station Biologists: L. deLambert, S. Graham, J. Mowdy.

3. Study Objectives:

a. Elucidate the population ecology of the spotted owl on the Tyee Study Area, northwest of Roseburg, Oregon to include estimates of population age structure, reproductive rates, and population trends.

b. Document trends in numbers of spotted owls in a bounded study area.

c. Document social integration of juveniles into the territorial population, to include age at pair formation and age at first breeding.

4. Potential Benefit or Utility of the Study:

The Tyee Demographic Study on the Roseburg District was designed to monitor age-specific birth and death rates of spotted owls, thereby allowing estimates of population trend over time. From these trends we make inferences regarding the suitability of the current habitat conditions and the effects of different landscape conditions on spotted owls.

Management of forest lands by the BLM and private landowners within the boundaries of the Tyee Study Area has led to a reduction of suitable owl habitat during the last 40-50 years (Thomas et al. 1993). Even though rates of harvest on BLM lands have declined since 1990, habitat conditions are still changing fairly rapidly in the study area, particularly on private lands. While the data collected during this study cannot be used to accurately predict future conditions, they can be used to assess predictive models that examine population projections under varying landscape conditions or management regimes (Anthony et al. 2000).

Since 1985 we have attempted to band all known fledglings in the study area. As a result, we are able to document the origin and age of most individuals that are recruited into the population. As a result, we have detailed information on population age structure and internal and external recruitment in the population within the study area.

5. Research Accomplishments:

Study Area and Methods

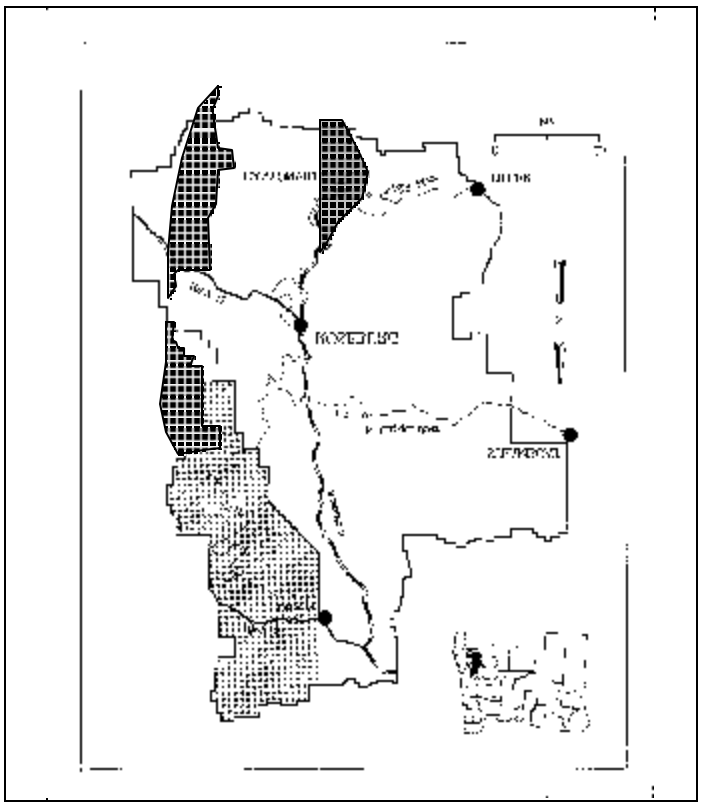

Fig 1. Tyee Study Area, Roseburg, Oregon. The shaded area represents the density study area (DSA). Areas indicated by the dark grid indicate areas outside the DSA.

The Tyee Study Area includes a 1025 km^2 Density Study Area (DSA) northwest of Roseburg, Oregon, plus adjacent areas on the Coos Bay and Roseburg BLM Districts within 6 miles of the western and eastern boundaries of the DSA (Fig. 1). The study area includes all or part of 4 Late-Successional Reserves (LSR's) as identified in the Northwest Forest Plan land-use alocations (USDA and USDI, 1994). Total size of the study area is approximately 1490 km^2. The 6 mile "buffer" around the DSA is intended to reduce the potential effects of non-juvenile emigration on estimates of adult survival in the DSA (Reid et al. 1996).

The DSA is subjected to a complete survey each year, allowing an estimate of the actual number of territorial birds. Surveys outside the DSA are primarily limited to historical sites where owls have been banded in previous years.

Methods used in this study and other demographic studies of spotted owls have been described in a variety of published sources (e.g., Forsman 1983, Franklin et al. 1990, Franklin 1992, Franklin et al. 1999). Protocols used for determination of reproductive parameters were described in Lint et al. (1999). Resightings and recaptures of previously banded owls are used to estimate survival rates (Pollock et al. 1990, Burnham et al. 1996).

Numbers of owls on the Tyee Study Area

Between March 1983 and October 2001, we banded 863 spotted owls on the Tyee Study Area, including 229 adults, 75 subadults, and 559 young of the year. The sex ratio of > 2-yr-old owls in the banded sample was slightly skewed towards males. By comparison, the sex ratio of subadults was approximately 1:1 (Table 1). The disproportionate number of males in the adult sample is most likely because males, especially unpaired males, are more detectable than unpaired females (Reid et al. 1999).

Table 1. Number of spotted owls banded, Tyee Study Area, Roseburg, Oregon: 1983-2001.

	Adults		Subadults		
Year	Male	Female	Male	Female	Fledglings
1983					2
1984	2	1		1	2
1985	13	13			1
1986	14	9			20
1987	11	9	2	3	10
1988	16	15	8	5	8
1989	18	8	3	2	22
1990	24	16	6	9	40
1991	8	9	6	3	28
1992	5	9	2	4	60
1993	2	4	1	2	13
1994	2	2	3	2	38
1995	1	1	0	1	21
1996	2	1	0	0	70
1997	1	0	0	0	33
1998	1	1	1	2	42
1999	1	3	2	1	33
2000	1	2	1	0	34
2001	3	1	2	3	82
Total	125	104			

The total number of non-juvenile spotted owls detected on the DSA has declined since 1990 (Fig. 2). However, the number of territorial pairs detected on the DSA was relatively constant among years (Fig. 2 and Appendix.1).

The maximum lifespan of a spotted owl in the wild is unknown. A few owls in other study areas have lived in excess of 15 years (Franklin, pers. comm, Ackers, pers. comm). Our study area has few owls older than 13 years. We knew the exact age of most owls (64%) located in the DSA in 2001 because they were originally banded as juveniles.

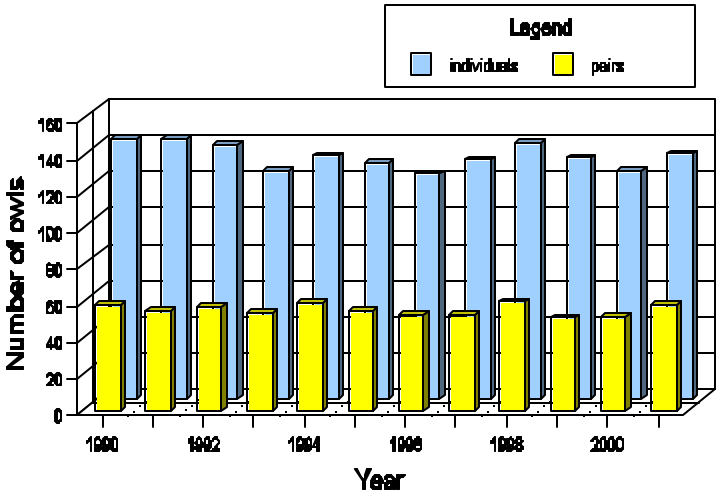

Fig. 2. Number of individuals and pairs of non-juvenile spotted owls on the Tyee DSA, Roseburg, Oregon, 1990-2001.

Estimated average age of territorial individuals detected in 2001 was 7.9 years for females and 6.8 years for males (Fig. 3). We documented 38 movements of individuals within the Tyee Study Area between 2000-2001. Of those, 19 were previously banded as juveniles and not previously documented in the resident population (new recruits to the population).

Average age at pair formation for known age individuals is 2.4 years for males and 1.9 years for females. Age at first nesting was similar for males and females (3.9 versus 3.5 years respectively).

In 2001, the population in the DSA was dominated by a large number of individuals recruited from cohorts of high reproductive years (1992 and 1996). If this pattern holds, we can expect to see a large recruitment from the 2001 cohort as well. In recent years, few individuals recruited into the resident population have been unbanded (Fig. 3). A large number of subadults was confirmed in the DSA in 2001, but the largest age class was 5-year-olds, coinciding with the high reproductive year of 1996 (Fig. 3).

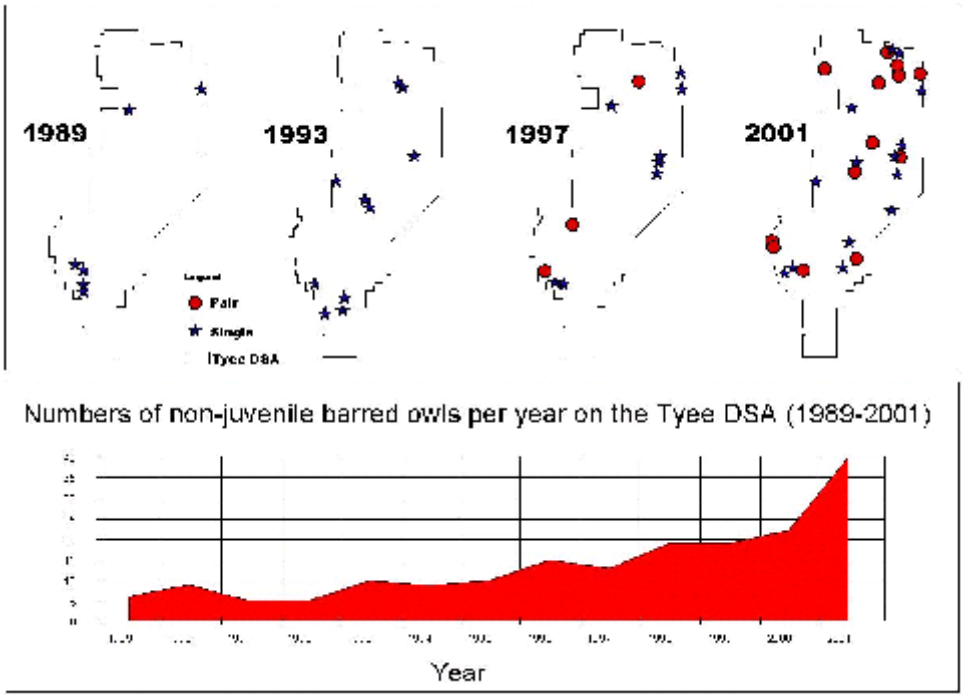

Fig. 4. Barred owl detections on the Tyee DSA, Roseburg, Oregon, 1989-2001.

In recent years, the number of barred owls in the DSA has increased rapidly (Fig. 4). This highly dynamic situation is of concern because we do not know if it will influence our recapture (resighting) rates of spotted owls. In addition, barred owls have displaced some pairs of spotted owls within the study area. Some of these displaced pairs have been relocated up to a mile away, in areas with previously undocumented spotted owl use. We have also witnessed violent attacks on spotted owls by barred owls that ended with the spotted owls fleeing for their lives. Although we have not yet confirmed a case where a barred owl killed a spotted owl, published accounts suggest

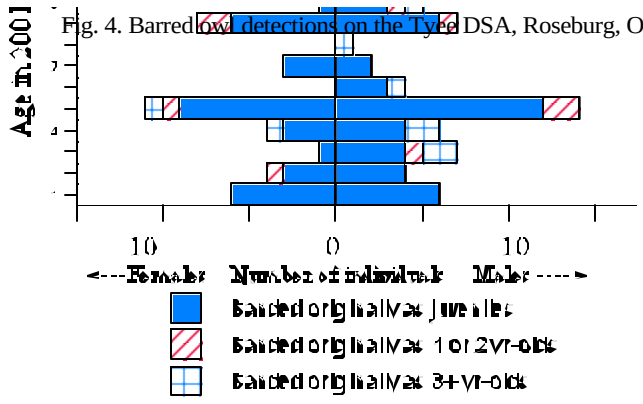

Fig. 3. Age distribution of spotted owls in 2001, Tyee DSA, Roseburg, Oregon.

that this does occur, at least occasionally (Leskiw and Gutierrez, 1998).

Reproduction

We summarized reproductive data for the entire Tyee Study Area. Because of the small sample size of subadults, yearly reproductive rates are presented for all ages combined (Tables 2, 3). Overall reproductive estimates are presented for the following age classes: 1-yr-old subadults (S1), 2-yr-old subadults (S2), adults (> 2 yrs old) (A), and age undetermined (U). We did not combine the 2 subadult age classes for this analysis because, where sample sizes permitted, there were significant differences between the 1-yr-old and 2-yr-old age classes (Tables 2, 3). Reproductive parameters for the 2-yr-old age class were more similar to the adult age class than to the 1-yr-old age class (Table 2).

The proportion of females that nested each year averaged 0.553 and varied among age classes (Table 2) and years (Table 4). The proportion of females that fledged young each year averaged 0.381 and also varied among age classes (Table 2) and years (Table 4).

Table 2. Average reproductive parameters of female spotted owls on the Tyee Study Area, Roseburg, Oregon: 1985-2001.

	Proportion nesting [1]			Proportion fledging young [2]			Proportion nesting that fledged young [3]		
Age	N	Prop.	95% C.I.	N	Prop.	95% C.I.	N	Prop.	95% C.I.
1st yr subadult	44	0.091	0.00-0.18	53	0.038	0.00-0.09	4	0.500	0.00-1.00
2nd yr subadult	57	0.404	0.27-0.54	64	0.250	0.14-0.36	23	0.652	0.44-0.86
Adult	743	0.59100	0.56-0.63	822	0.412	0.38-0.45	439	0.729	0.67-0.79
Unknown	13	0.615	0.31-0.92	32	0.406	0.23-0.59	8	0.250	0.00-0.64

[1] Estimates were calculated for females whose nesting status was determined by 1 June.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose nesting status was determined by 1 June and reproductive status by 31 August.

Table 3. Average fecundity and brood size of female spotted owls on the Tyee Study Area, Roseburg, Oregon: 1985-2001.

	Fecundity [4]		Mean brood size		
		SE	N	Mean	SE
		0.026	2		
		0.050	16	1.750	0.112
		0.015	339	1.578	0.027
		0.059	13	1.231	0.122

[4] Fecundity is defined as number of female young produced per female.

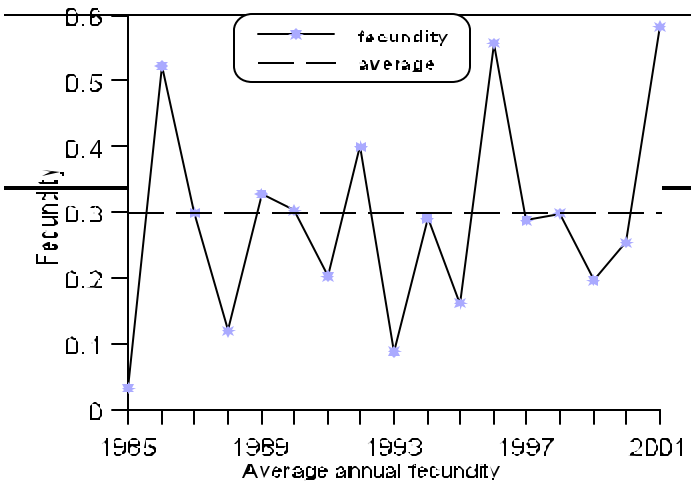

Fig. 5. Average annual fecundity on the Tyee Study Area, Roseburg, Oregon, 1985-2001.

Nesting success, which we defined as the proportion of nesting females that fledged young, averaged 0.720. Excluding the first year of the study (1985), nesting success ranged from 0.429-0.946 (Table 3). Nesting success differed among the 4 main age classes (P^2 = 34.660, 3 df, P<0.001), but did not differ between the

2-yr-old and adult age classes (P^2 = 0.353, 1 df, P < 0.552)(Table 2).

We defined annual fecundity as the number of female young produced per female. We estimated fecundity by counting the number of young that left the nest, and dividing by 2 (i.e., we assumed a 1:1 sex ratio). Estimated annual fecundity averaged 0.300 (Appendix 2) and varied among years (Fig. 5). Fecundity differed among the four main age classes (F = 9.393, 3 df, P<0.001), but did not differ between 2-yr-old and adult owls (F = 3.850, 1 df, P = 0.050)(Table 4). The high among-year variation in reproductive rates that we observed is typical of spotted owls (Forsman et al. 1984, Franklin et al. 1999) . However, in contrast to some other study areas, high and low reproductive years on the Tyee Study Area did not consistently follow an alternate year pattern (Fig. 5).

Table 4. Proportion of female spotted owls that nested, fledged young, and nested and fledged young, Tyee Study Area, Roseburg, Oregon: 1985-2001.

	Proportion nesting [1]			Proportion fledging young[2]			Proportion nesting that fledged young[3]		
Year	N	Prop.	95% C.I.	N	Prop.	95% C.I.	N	Prop.	95% C.I.
1985	11	0.182	0.00-0.45	15	0.067	0.00-0.21	2	0.000	0.00-1.00
1986	18	0.833	0.64-1.00	22	0.682	0.47-0.89	15	0.733	0.48-0.98
1987	8	0.500	0.00-0.95	10	0.400	0.03-0.77	4	0.750	0.00-1.00
1988	18	0.389	0.14-0.64	25	0.200	0.03-0.37	7	0.429	0.00-0.92
1989	21	0.762	0.56-0.96	32	0.469	0.29-0.65	16	0.625	0.36-0.89
1990	63	0.730	0.62-0.84	76	0.487	0.37-0.60	46	0.696	0.56-0.83
1991	68	0.426	0.31-0.55	74	0.243	0.14-0.34	29	0.586	0.40-0.78
1992	74	0.554	0.44-0.67	80	0.475	0.36-0.59	41	0.854	0.74-0.97
1993	65	0.246	0.14-0.35	73	0.110	0.04-0.18	16	0.438	0.16-0.71
1994	72	0.556	0.44-0.67	74	0.392	0.28-0.51	40	0.700	0.55-0.85
1995	63	0.365	0.24-0.49	71	0.211	0.11-0.31	23	0.522	0.30-0.74
1996	61	0.820	0.72-0.92	70	0.629	0.51-0.75	50	0.800	0.69-0.92
1997	61	0.574	0.45-0.70	66	0.348	0.23-0.47	35	0.657	0.49-0.82
1998	70	0.557	0.44-0.68	77	0.416	0.30-0.53	39	0.744	0.60-0.89
1999	53	0.472	0.33-0.61	66	0.273	0.16-0.38	25	0.680	0.48-0.88
2000	62	0.484	0.36-0.61	67	0.313	0.20-0.43	30	0.633	0.45-0.82
					0.644	0.53-0.76	56	0.946	0.63-1.00
					0.381	0.35-0.41	514	0.720	0.68-0.76

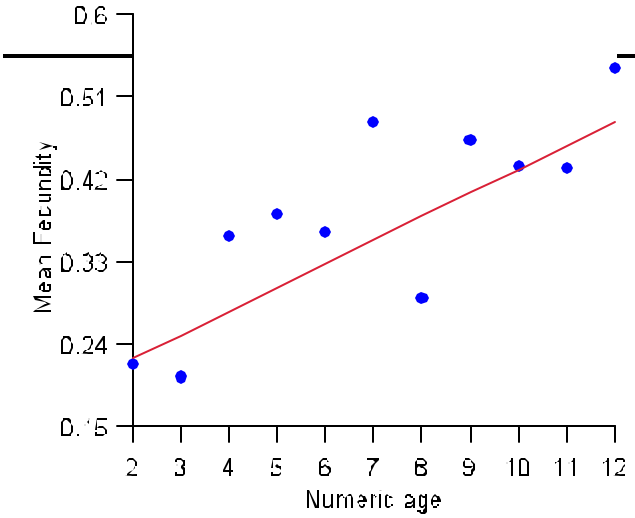

Figure 6. Fecundity of known age females on the Tyee Study Area, 1988-2001.

[1] Estimates were calculated for females whose nesting status was determined by 1 June.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose nesting status was determined by 1 June and reproductive status by 31 August.

We compared mean fecundity of known age territorial females to determine if fecundity varied with age. Only 2- to 12-year-old owls were included in the analysis due to small sample sizes of owls that were 1-year-old or >12-years-old. Mean fecundity increased with age, at least up to age 12 (R^2 = 0.64, P = 0.003) (Fig. 6). However, further examination of the data revealed no

differences in fecundity between 2-yr-old and 3 yr-old owls or among owls that were 4-12-years-old (F = 0.450, 8 df, P = 0.890)(Fig. 6).

Mean brood size was defined as the number of young fledged per female that successfully fledged young. Estimated mean brood size was 1.58 and varied among age classes (F = 3.247, 3 df, P = 0.022). However, mean brood size did not differ between the 2-yr-old and adult age classes (F = 1.816, 1 df, P = 0.179) (App.2).

6. Discussion

The number of individuals detected in the DSA declined slightly from 1990-2001, but the number of territorial pairs appeared to change little. The age structure of the population indicates that there were few owls over 13 years of age. Recruitment usually occurs early and may indicate that all available habitat is occupied. The population age structure does reflect years of high reproduction, but maintains a fairly constant age distribution.

Our data clearly demonstrate that barred owls are increasing in numbers and are occupying previously occupied spotted owl sites. Although at this time, the numbers of spotted owl pairs in the study area seems relatively stable, the loss of long-term productive spotted owl sites to barred owls should be monitored closely.

7. Publications and Presentations:

a. Participated in the analysis of *Demographic Performance of Spotted Owls in Relation to Landscape Patterns*.

b. Provided data on barred owls to OSU student for analysis in master's thesis.

c. A paper on natal and post natal dispersal of spotted owls was accepted for publication, as a wildlife monograph.

d. A presentation on *Natal and Post-natal Dispersal* was given to federal biologists and managers.

e. We provided information to many different private and state organizations for their management purposes.

f. A presentation on *Demographic Performance of Spotted Owls in Relation to Landscape Patterns* was given to representatives of the 3 major timber companies which own land within the study area.

g. We provided Michael MacGrath of the Oregon Cooperative Wildlife Research Unit with information on site occupancy and reproduction of spotted owl sites.

h. We provided bands and technical oversight in banding of spotted owls on Weyerhaeuser lands adjacent to the Tyee Study Area.

i. We provided survey information to the Eugene District and Coos Bay District of the BLM of the sites

that we surveyed in their district. We provided site and summary information to the Oregon State Office of the BLM for the Coos Bay and Roseburg Districts.

j. We provided nest tree data and barred owl data to Oregon Cooperative Research Unit biologists for analysis.

k. We provided genetic material from spotted owls to Susan Haig of USFS, Corvallis, Oregon.

8. Acknowledgments

This study was funded by the USDI Bureau of Land Management and the USDA Forest Service, Pacific Northwest Forestry Sciences Lab. The Roseburg District of the BLM provided invaluable support in all phases of the research. We would like to thank the Weyerhaeuser Company, Roseburg Resources, Juniper Properties, and Seneca Timber Company for allowing us access to their lands. The consultants *Biota Pacific* and ABR provided spotted owl visit information to us.

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Appendix 1. Number of spotted owls detected within the Tyee Density Study Area (DSA), Roseburg, Oregon: 1987-2001.

		>2yr-old		1- 2-yr-old		Age Unknown			Non-juveniles
Year	Pairs	M	F	M	F	M	F	Fledglings	detected
1987	27	25	20	2	3	6	4	10	60
1988	37	30	28	10	7	6	3	6	84
1989	47	46	39	4	2	11	11	23	113
1990	58	61	49	7	10	7	8	34	142
1991	55	60	51	12	6	7	6	26	142
1992	57	60	52	10	8	4	5	48	139
1993	54	56	44	8	9	4	4	11	125
1994	59	60	51	10	9	1	2	33	133
1995	55	63	54	1	3	2	6	18	129
1996	53	56	51	5	5	4	2	60	123
1997	53	57	49	14	6	4	1	29	131
1998	60	53	46	18	14	5	4	38	140
1999	51	58	50	8	4	9	3	29	132
2000	52	57	53	5	2	5	3	28	125
2001	58	61	51	9	8	1	3	67	135

M=Males, F=Females

Appendix 2. Estimated fecundity ($\hat{b}$) and mean brood size of female spotted owls on the Tyee Study Area: 1985-2001. Fecundity defined as the number of female young produced per female owl. Estimates were calculated for individual females for which reproductive output was documented by 31August.

	Fecundity			Mean brood size		
Year	N	Mean	SE	N	Mean	SE
1985	15	0.033	0.033	1		
1986	22	0.523	0.090	15	1.533	0.133
1987	10	0.300	0.133	4	1.500	0.289
1988	25	0.120	0.052	5	1.200	0.200
1989	32	0.328	0.070	15	1.400	0.131
1990	76	0.303	0.040	37	1.243	0.072
1991	74	0.203	0.044	18	1.667	0.114
1992	80	0.400	0.051	38	1.684	0.076
1993	73	0.089	0.031	8	1.625	0.183
1994	74	0.291	0.046	29	1.483	0.094
1995	71	0.162	0.040	15	1.533	0.133
1996	70	0.557	0.055	44	1.773	0.064
1997	66	0.288	0.052	23	1.652	0.102
1998	77	0.299	0.046	32	1.438	0.089
1999	66	0.197	0.043	18	1.444	0.121
2000	67	0.254	0.049	21	1.619	0.109
2001	73	0.582	0.055	47	1.809	0.066
Total	971	0.300	0.013	370	1.58	0.026